Quadruple Pendulum Design Update

Norna A Robertson
Stanford University and University of Glasgow

for the GEO 600 and LIGO suspension teams

LSC meeting, Hannover, August 19th 2003
Plenary Technical Session

DCC Number: LIGO-G030437-00-Z

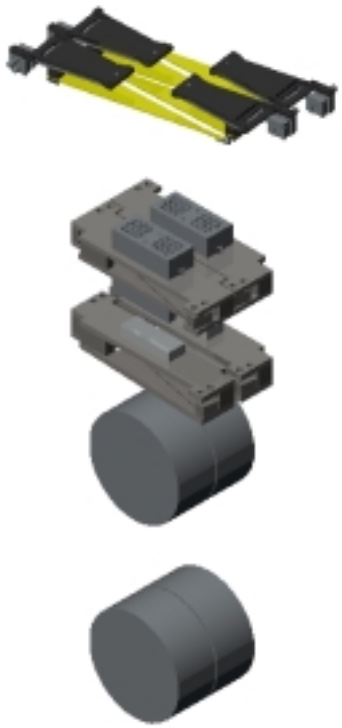
Recent Developments

- more time required for sapphire/silica downselect +
- firm mass estimate for seismic platform loading required -->
  - develop design with potential for incorporating either sapphire or silica test mass +
  - minimise overall mass consistent with meeting requirements

Current Design

- Test mass:40 kg
  - baseline: sapphire, 31.4 cm (diam) x 13 cm
  - fallback: silica, 34 cm (diam) x 20 cm
- Penultimate mass: 40 kg
  - ‘same’ dimensions as test mass
    (sapphire/SF4 for sapphire test mass, silica for silica test mass)
- Other masses: 22kg, 22kg
- Common design of upper masses, blades, wire lengths, etc. --> MATLAB/SIMULINK model used to check performance

Quad Layout for End Test Mass (ETM) Chain + Reaction Chain

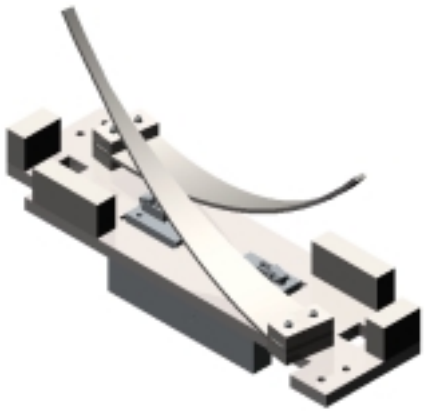


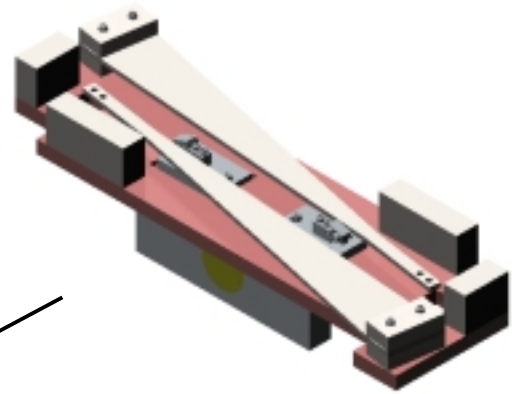
Baseline w/ sapphire test mass

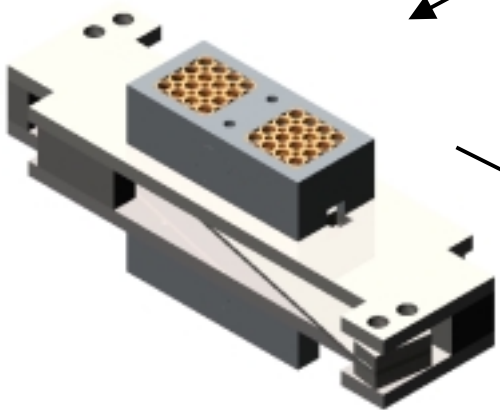
Fallback - silica

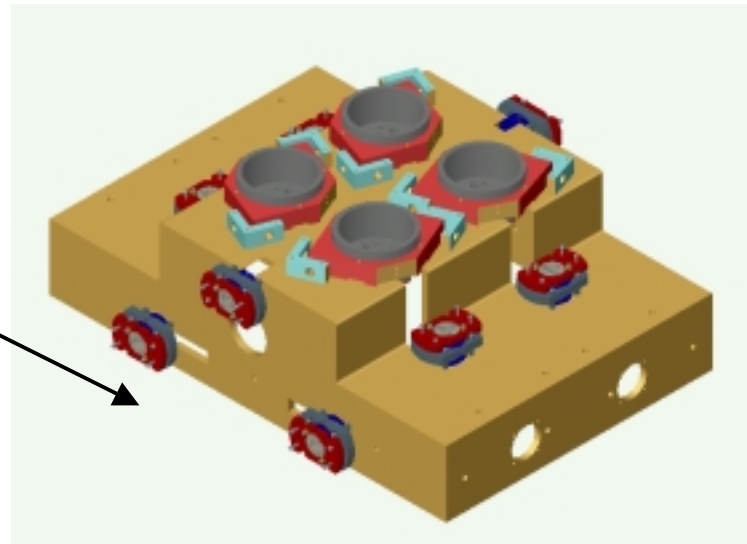
C Torrie, M Perreur-Lloyd

Top Mass



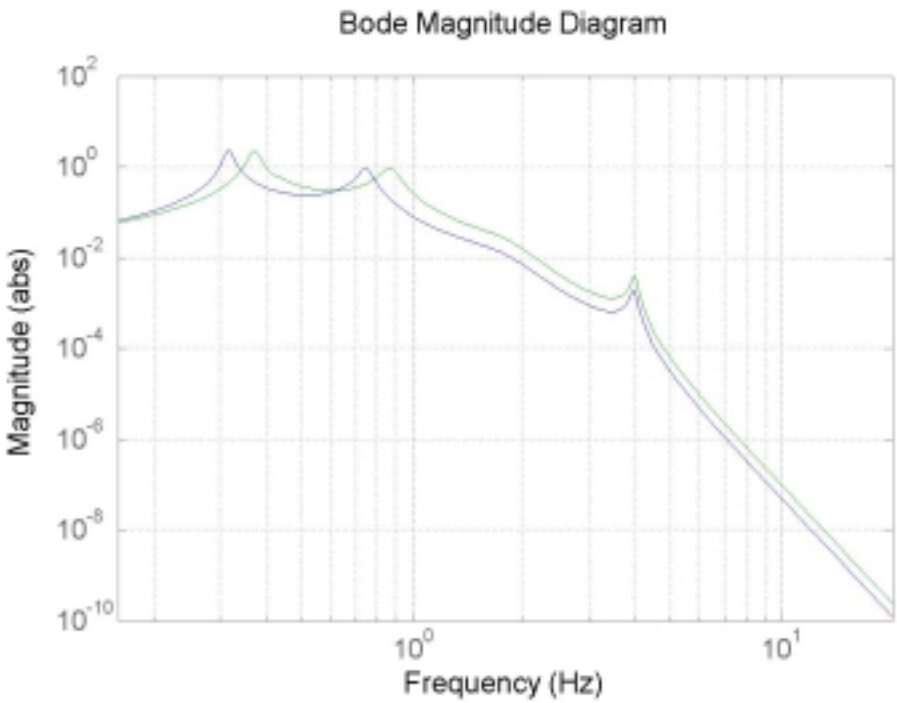


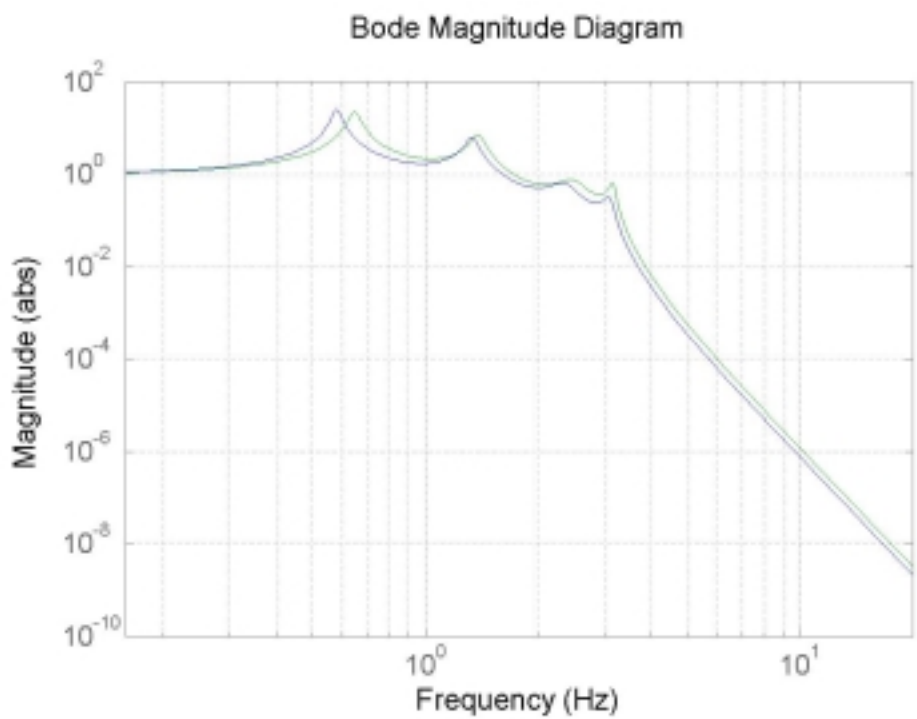




C Torrie, M Perreur-Lloyd

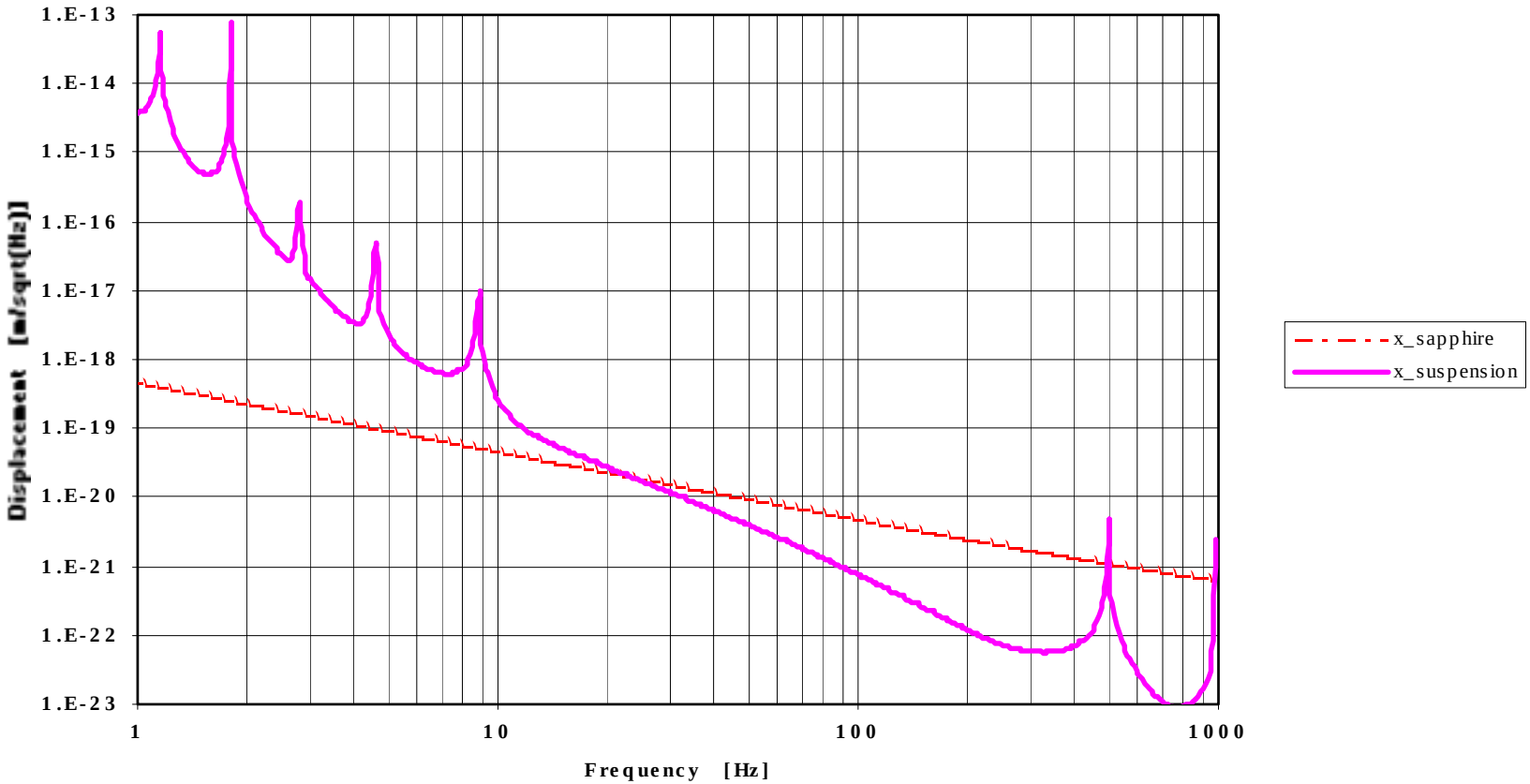
Pitch and Yaw





Green:sapphire test mass
Blue:silica test mass

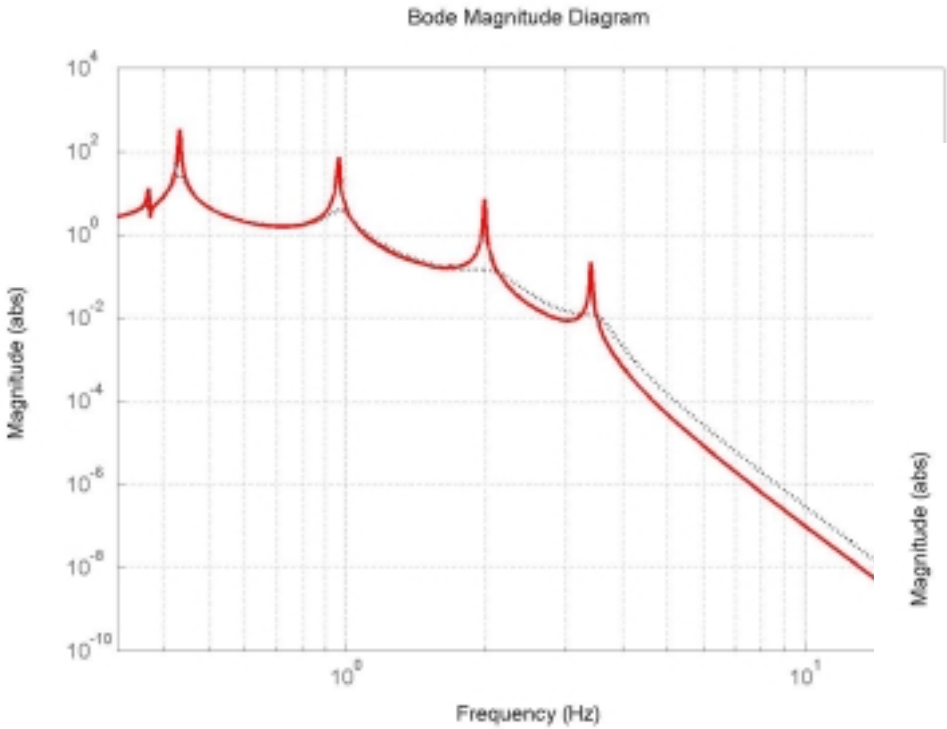
Thermal Noise Estimate



Magenta: suspension thermal noise estimate
Red: baseline sapphire internal noise estimate (no coatings)
Final stage: 60 cm silica ribbons 1.13 mm x 0.11 mm
Vertical bounce mode: 8.8 Hz, first violin mode: ~490 Hz

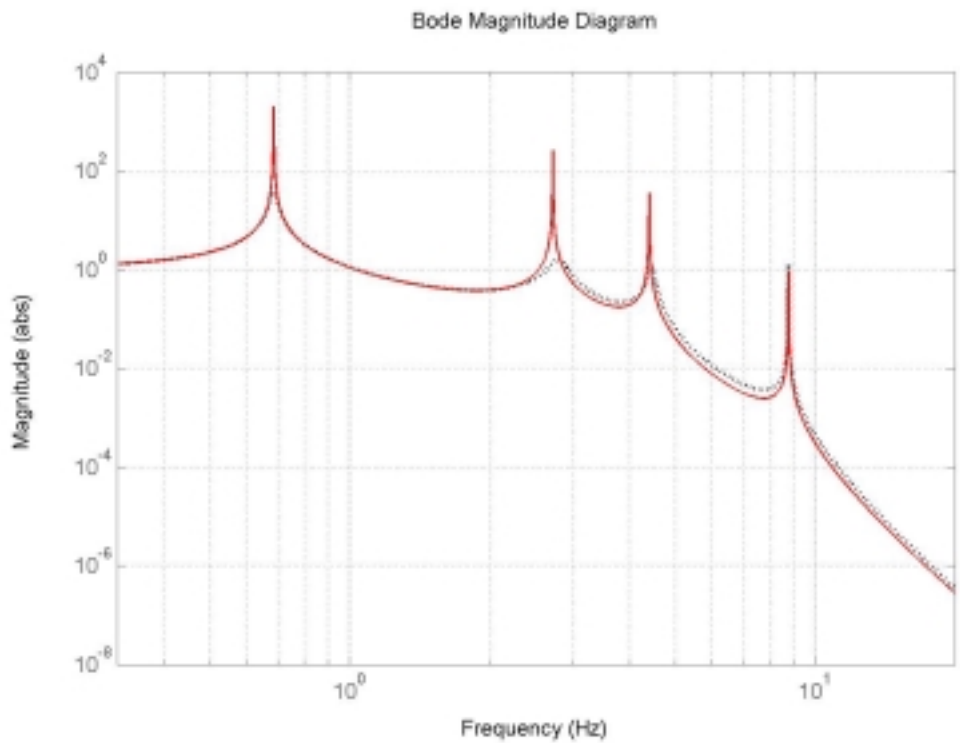
G Cagnoli

Longitudinal and Vertical Transfer Functions



Longitudinal TF

Vertical TF



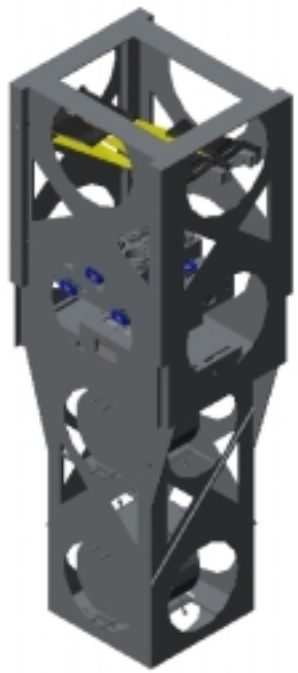
Black curve: with active damping
Red curve: without

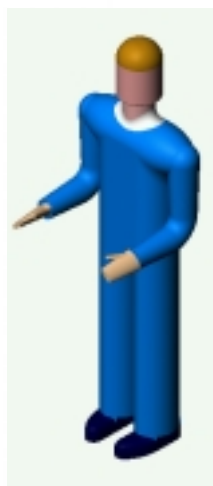
Open Issues/Current Work

- *Design of 'fibres'*: ribbons or dumbbell fibres can meet suspension thermal noise requirements – research on both in progress at Glasgow and Caltech
- *Bonding*: ongoing investigations
  - see presentations by C Cantley and H Armandula
- *Local Control*: possible solution to sensor noise "problem" for ETM
  - For longitudinal, yaw and pitch – use global control signals to take over once interferometer locked, and turn down active control gain
  - For transverse: current noise level sufficiently quiet
  - For vertical and roll: turn down active control gain and use eddy current damping to damping times ~ 100 - 200 secs
  - see presentations by K Strain and M Plissi
- *Other BSC suspensions*: beamsplitter, folding mirror, compensation plate – work starting on designs

Current Work contd

- ETM Mass and C of G estimate for whole assembly including support structure + considerations of method of assembly - see presentation by C Torrie





Finally..

- Advanced LIGO Suspension System Conceptual Design (T010103) currently being updated
  - BSC (quadruple) and HAM (triple) suspensions included
  - reflects developments since Sept 2001